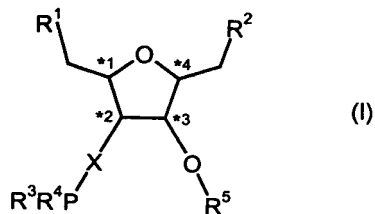


**WHAT IS CLAIMED IS:**

1. Compounds of the formula (I)



where

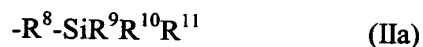
\*1, \*2, \*3 and \*4 are each independently a stereogenic carbon atom which has R- or S- configuration,

X is absent or is oxygen and

R<sup>1</sup> and R<sup>2</sup> may each independently be hydrogen, C<sub>1</sub>-C<sub>20</sub>-alkyl, C<sub>1</sub>-C<sub>20</sub>-fluoroalkyl, C<sub>2</sub>-C<sub>20</sub>-alkenyl, C<sub>4</sub>-C<sub>24</sub>-aryl, C<sub>5</sub>-C<sub>25</sub>-arylalkyl, C<sub>6</sub>-C<sub>26</sub>-arylalkenyl or NR<sup>6</sup>R<sup>7</sup>, OR<sup>7</sup>, -(C<sub>1</sub>-C<sub>8</sub>-alkyl)-OR<sup>7</sup>, -(C<sub>1</sub>-C<sub>8</sub>-alkyl)-NR<sup>6</sup>R<sup>7</sup> or -O<sub>2</sub>CR<sup>7</sup>,

where R<sup>6</sup> and R<sup>7</sup> are each independently C<sub>1</sub>-C<sub>8</sub>-alkyl, C<sub>5</sub>-C<sub>15</sub>-arylalkyl or C<sub>4</sub>-C<sub>14</sub>-aryl, or R<sup>6</sup> and R<sup>7</sup> together are a cyclic amino radical having a total of 4 to 20 carbon atoms,

or R<sup>1</sup> and R<sup>2</sup> are each independently radicals of the formula (IIa)



where

$R^8$  is absent or is oxygen or methylene and

$R^9$ ,  $R^{10}$  and  $R^{11}$  are each independently  $C_1$ - $C_{12}$ -alkyl,  $C_5$ - $C_{15}$ -arylalkyl or  $C_4$ - $C_{14}$ -aryl and

5

$R^3$  and  $R^4$  are each independently  $R^{12}$ ,  $OR^{13}$  or  $NR^{14}R^{15}$  where  $R^{12}$ ,  $R^{13}$ ,  $R^{14}$  and  $R^{15}$  are each independently  $C_1$ - $C_{12}$ -alkyl,  $C_5$ - $C_{15}$ -arylalkyl or  $C_4$ - $C_{14}$ -aryl, or  $NR^{14}R^{15}$  together is a cyclic amino radical having 4 to 20 carbon atoms, or  $R^3$  and  $R^4$  together are  $-O-R^{16}-O-$  where  $R^{16}$  is a radical selected from the group of  $C_2$ - $C_4$ -alkylene, 1,2-phenylene, 1,3-phenylene, 1,2-cyclohexylene, 1,1'-ferrocenylene, 1,2-ferrocenylene, 2,2'-(1,1'-binaphthylene), 2,2'-(1,1'-biphenylene and 1,1'-(diphenyl-2,2'-methylene)diyl, and the radicals mentioned may optionally be mono- or polysubstituted by radicals selected from the group of fluorine, chlorine,  $C_1$ - $C_8$ -alkoxy and  $C_1$ - $C_8$ -alkyl and

10

15

$R^5$  is hydrogen,  $C_1$ - $C_{20}$ -alkyl,  $C_4$ - $C_{24}$ -aryl,  $C_5$ - $C_{25}$ -arylalkyl,  $C_1$ - $C_{20}$ -haloalkyl or a radical of the formula (IIb)

20



where

A is absent or is  $C_1$ - $C_{12}$ -alkylene

25

B is a functionality which is selected from the group of



where

R<sup>17</sup> may be C<sub>1</sub>-C<sub>20</sub>-alkyl, C<sub>4</sub>-C<sub>24</sub>-aryl, C<sub>5</sub>-C<sub>25</sub>-arylalkyl

and

5 D is C<sub>1</sub>-C<sub>8</sub>-alkyl, C<sub>4</sub>-C<sub>24</sub>-aryl or C<sub>5</sub>-C<sub>25</sub>-arylalkyl or

B and D, in the case that A is not absent, are together optionally cyano or  
[(C<sub>1</sub>-C<sub>8</sub>-alkylene)-O]<sub>n</sub>-(C<sub>1</sub>-C<sub>8</sub>-alkyl) where n is an integer between  
1 and 8 or

10

R<sup>17</sup> and D together are a cyclic amino radical having 4 to 12 carbon atoms.

2. Compounds according to Claim 1, characterized in that \*1, \*2, \*3 and \*4  
together define the following stereoisomers of the central substituted furan  
15 ring:

(1R,2R,3R,4R), (1R,2R,3R,4S), (1R,2S,3S,4S), (1R,2S,3S,4R),  
(1R,2R,3S,4R), (1S,2S,3R,4S), (1S,2S,3S,4S), (1S,2S,3S,4R),  
(1S,2R,3R,4R), (1S,2R,3R,4S), (1S,2S,3R,4S), (1R,2R,3S,4R).

20

3. Compounds according to Claim 1, characterized in that R<sup>1</sup> and R<sup>2</sup> are each  
independently hydrogen, tert-butoxy, trityloxy, tert-butyldimethylsilyloxy,  
tert-butyldiphenylsilyloxy, trimethylsilyloxy, triethylsilyloxy,  
triisopropylsilyloxy, neopentoxy or 1-adamantoxy.

25

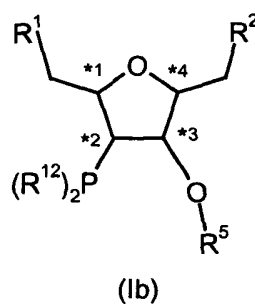
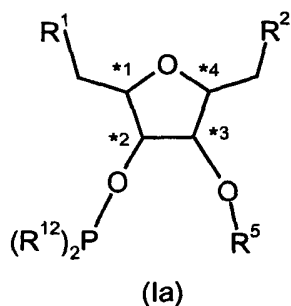
4. Compounds according to Claim 1, characterized in that R<sup>1</sup> and R<sup>2</sup> are  
identical.

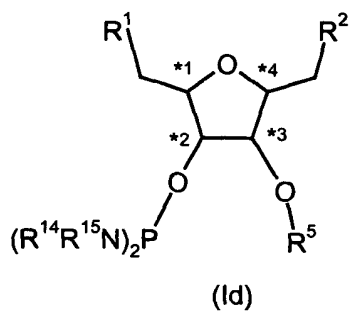
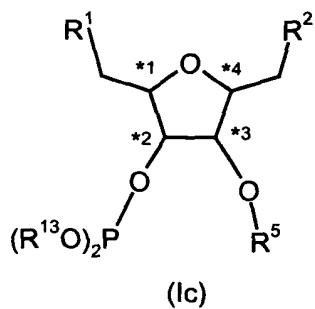
5. Compounds according to Claim 1, characterized in that R<sup>3</sup> and R<sup>4</sup> are each  
30 independently R<sup>12</sup>, OR<sup>13</sup> or NR<sup>14</sup>R<sup>15</sup> where R<sup>12</sup>, R<sup>13</sup>, R<sup>14</sup> and R<sup>15</sup> are each

independently C<sub>1</sub>-C<sub>12</sub>-alkyl or C<sub>4</sub>-C<sub>14</sub>-aryl, or NR<sup>14</sup>R<sup>15</sup> together is a cyclic amino radical having 4 to 12 carbon atoms, or R<sup>3</sup> and R<sup>4</sup> together are -O-R<sup>16</sup>-O- where R<sup>16</sup> is ethylene, 1,2-phenylene, 1,3-phenylene, 1,2-cyclohexylene, 1,1'-ferrocenylene, di- or tetra-C<sub>1</sub>-C<sub>8</sub>-alkyl-substituted 1,1'-(diphenyl-2,2'-methylene)diyl, 1,2-ferrocenylene, 2,2'-(1,1'-binaphthylene) or 2,2'-(1,1')-biphenylene, and 2,2'-(1,1'-binaphthylene) or 2,2'-(1,1')-biphenylene is substituted at least in the 6,6'-position by radicals which are selected from the group of C<sub>1</sub>-C<sub>8</sub>-alkoxy and C<sub>1</sub>-C<sub>8</sub>-alkyl, and is optionally substituted in the 5,5'-, 4,4'-, 3,3'- or 2,2'-position by radicals which are selected from the group of fluorine, chlorine, C<sub>1</sub>-C<sub>8</sub>-alkoxy and C<sub>1</sub>-C<sub>8</sub>-alkyl.

6. Compounds according to Claim 1, characterized in that R<sup>5</sup> is hydrogen, C<sub>1</sub>-C<sub>4</sub>-alkyl, -CO(C<sub>1</sub>-C<sub>4</sub>-alkyl), benzyl-CO-phenyl or phenyl, and benzyl or phenyl is optionally further substituted by one, two or three substituents selected from the group of C<sub>1</sub>-C<sub>4</sub>-alkyl, C<sub>1</sub>-C<sub>4</sub>-alkoxy or C<sub>1</sub>-C<sub>4</sub>-haloalkyl.

7. Compounds according to Claim 1, characterized in that they are of the formulae (Ia) to (Id)





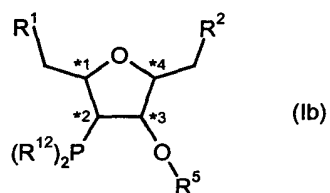
where \*1,\*2,\*3,\*4,  $R^1$ ,  $R^2$ ,  $R^5$ ,  $R^{12}$ ,  $R^{13}$ ,  $R^{14}$  and  $R^{15}$  are as defined under formula (I).

5

8. 2-*O*-(Di(2,4-dimethylphenyl)phosphino)-1,6-di-*O*-(*tert*-butyldiphenylsilyl)-2,5-anhydro-D-mannitol.

9. Process for preparing compounds of the formula (Ib)

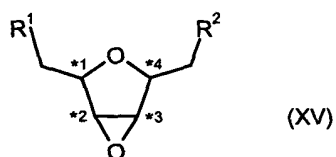
10



where

15

$R^1$ ,  $R^2$ ,  $R^5$ ,  $R^6$  and  $R^{12}$  are as defined under formula (I), comprising converting compounds of the formula (XV)



where

$R^1$  and  $R^2$  are as defined under formula (I),

in the presence of compounds of the formula (XVI),

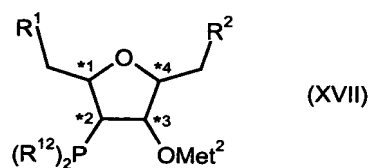


where

$\text{Met}^2$  is lithium, sodium or potassium and

10  $R^{12}$  has the definition specified under (I),

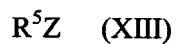
to compounds of the formula (XVII)



15 where

$R^1$ ,  $R^2$ ,  $\text{Met}^2$  and  $R^{12}$  are as defined above, and

20 reacting the compounds of the formula (XVII) with compounds of the formula (XIII),



where

25  $R^5$  has the same definitions as specified under formula (I) and

Z is chlorine, bromine, iodine or  $R^{19}SO_3$  where  $R^{19}$  is  $C_1$ - $C_{12}$ -alkyl,  $C_1$ - $C_{12}$ -haloalkyl,  $C_5$ - $C_{25}$ -arylalkyl or  $C_4$ - $C_{24}$ -aryl, and, in the case that  $R^5$  is to be bonded via a carbonyl group, is optionally  $R^5O$ -.

- 5    10. Transition metal complexes containing compounds according to Claim 1 and a transition metal compound.
  11. Transition metal complexes according to Claim 10, characterized in that the transition metal is selected from the group of ruthenium, osmium,  
10 cobalt, rhodium, iridium, nickel, palladium, platinum and copper.
  12. Transition metal complexes according to Claim 10, characterized in that the molar ratio of transition metal to the compounds is 1:2, 1:3 or 1:4.
  - 15    13. Transition metal complexes according to Claim 10, which is of the formula (XIX)
- $$[(I)_4M] \quad (XIX)$$
- where
- 20    (I) is a compound of the formula (I) as defined in claim 1 and
- M is rhodium or iridium.
- 25    14. Transition metal complexes according to Claim 10 characterized in that they are obtained by reacting the transition metal compounds and the compounds .
  15. Transition metal complexes according to Claim 14, characterized in that  
30 the transition metal compounds used are:

transition metal compounds of the formula (XXa)



where

5

M is rhodium, iridium, ruthenium, nickel, palladium, platinum or copper and

10

An<sup>1</sup> is chloride, bromide, acetate, nitrate, methanesulphonate, trifluoromethanesulphonate or acetylacetonate and

q is 3 for rhodium, iridium and ruthenium, is 2 for nickel, palladium and platinum, and is 1 for copper,

15

or transition metal compounds of the formula (XXb)



where

20

M is ruthenium, iridium, ruthenium, nickel, palladium, platinum or copper and

25

An<sup>2</sup> is chloride, bromide, acetate, methanesulphonate or trifluoromethanesulphonate, tetrafluoroborate or hexafluorophosphate, perchlorate, hexafluoroantimonate, tetra(bis-3,5-trifluoromethylphenyl)borate or tetraphenylborate and

q is 1 for rhodium and iridium, is 2 for ruthenium, nickel, palladium and platinum, and is 1 for copper,

30



$L^1$  is in each case  $C_2$ - $C_{12}$ -alkene, , or a nitrile, or

$L^1_2$  together is a  $(C_4$ - $C_{12})$ -diene,,

5 or transition metal compounds of the formula (XXc)



where

10  $M$  is ruthenium and

$L^2$  is an aryl radical, or methylallyl,

or transition metal compounds of the formula (XXd)

15



where

$M$  is palladium, nickel, iridium or rhodium and

20

$An^3$  is chloride or bromide and

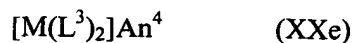
$Met^3$  is lithium, sodium, potassium, ammonium or an organic ammonium ion and

25

$q$  is 3 for rhodium and iridium, and is 2 for nickel, palladium and platinum,

or transition metal compounds of the formula (XXe)

30



where

M is iridium or rhodium and

L<sup>3</sup> is (C<sub>4</sub>-C<sub>12</sub>)-diene, and

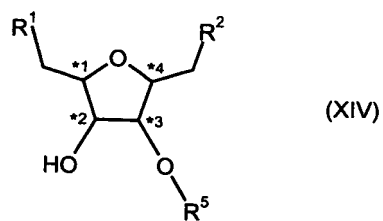
An<sup>4</sup> is an uncoordinating or weakly coordinating anion,  
methanesulphonate, trifluoromethanesulphonate, tetrafluoroborate,  
hexafluorophosphate, perchlorate, hexafluoroantimonate, tetra(bis-  
3,5-trifluoromethylphenyl)borate or tetraphenylborate,

or Ni(1,5-cyclooctadiene)<sub>2</sub>, Pd<sub>2</sub>(dibenzylideneacetone)<sub>3</sub>, Pd[PPh<sub>3</sub>]<sub>4</sub>,  
cyclopentadienyl<sub>2</sub>Ru, Rh(acac)(CO)<sub>2</sub>, Ir(pyridine)<sub>2</sub>(1,5-cyclooctadiene),  
Cu(phenyl)Br, Cu(phenyl)Cl, Cu(phenyl)I, Cu(PPh<sub>3</sub>)<sub>2</sub>Br,  
[Cu(CH<sub>3</sub>CN)<sub>4</sub>]BF<sub>4</sub> and [Cu(CH<sub>3</sub>CN)<sub>4</sub>]PF<sub>6</sub> or multinuclear bridged  
complexes.

16. Transition metal complexes according to Claim 14, characterized in that  
the amount of the metal in the transition metal compounds used is from 5  
to 100 mol%.
17. Catalysts containing transition metal complexes according to Claim 10.
18. A process for preparing stereoisomerically enriched compounds  
comprising providing transition metal complexes according to Claim 10 or  
catalysts containing the transition metal complexes.
19. The process of o Claim 18, characterized in that the stereoisomerically  
enriched compounds are obtained by asymmetric 1,4-additions,

asymmetric hydroformylations, asymmetric hydrocyanations, asymmetric Heck reactions and asymmetric hydrogenations.

20. The process of Claim 18, characterized in that the stereoisomerically enriched compounds are used for preparing active ingredients in pharmaceuticals and agrochemicals, or intermediates of both of these classes.
21. Process for preparing stereoisomerically enriched compounds by catalytic hydrogenations of olefins, enamines, enamides, imines or ketones, 1,4-additions, hydroformylations, hydrocyanations or Heck reactions, comprising providing catalysts which contain transition metal complexes according to Claim 10.
22. Process according to Claim 21, characterized in that the amount of the transition metal complexes used is 0.001 to 5 mol%, based on substrate used.
23. Process according to Claim 21, characterized in that the stereoisomerically enriched compounds are obtained by catalytic hydrogenation of olefins, enamides or imines.
24. Process according to Claim 21, characterized in that the working temperature is  $-20^{\circ}\text{C}$  to  $200^{\circ}\text{C}$ .
25. Process according to Claim 21, characterized in that the hydrogen pressure is 0.1 to 200 bar.
26. Compounds of the formula (XIV)

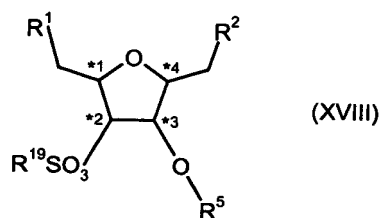


where

$R^1$ ,  $R^2$  and  $R^5$  are each as defined under formula (I) in Claim 1.

5

27. Compounds of the formula (XVIII)



where

10

$R^1$ ,  $R^2$  and  $R^5$  are each as defined under formula (I) in Claim 1 and

$R^{19}$  is  $C_1$ - $C_{12}$ -alkyl,  $C_1$ - $C_{12}$ -fluoroalkyl,  $C_5$ - $C_{25}$ -arylalkyl or  $C_4$ - $C_{24}$ -aryl.